



Original Communication

Toxicoepidemiology of fatal poisonings in Southern India[☆]

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ABSTRACT

An autopsy based retrospective study was conducted from January 2000 to December 2006 at Manipal in Southern India, and a profile of the victims of poisoning was prepared. The study was done to understand the magnitude and pattern of all poisoning fatalities in relation to the manner of death in Manipal region of Southern India. The study included a total of 198 cases of fatal poisoning. Self-poisoning was reported in 92.9% cases. Fatal accidental poisoning was seen in 6.1% cases. Homicide by poisoning was not reported during the study period. Uncertainty regarding the manner of death due to poisoning was observed only in two cases. Males were predominantly affected (71.2%). The majority of the victims were in the 3rd decade (28.3%) of life. The age of the victims ranged from 2 to 82 years with a mean age of 38.4 years. While majority of the victims consumed poison during daytime, most of the poisoning fatalities were reported during summer months. Organophosphate compounds were implicated in 68.7% of the total poisoning related fatalities. Males in the 3rd to 5th decades were prone to self-poisoning with organophosphate compounds. Accidental poisoning deaths were uncommon and poisoning was not a preferred method of homicide in this region. Our approach to the study reveals that quantitative chemical (toxicological) analysis is required to further strengthen and improve the databases of epidemiology of poisoning in our region.

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1. Introduction

Acute poisoning is a serious global problem and a leading cause of morbidity and mortality worldwide. More than 90% of fatal poisonings occur in developing countries, particularly amongst agricultural workers.¹ In developed countries, the rate of mortality from poisoning is 1–2%, but in India it varies from 20% to 30% or even more.² The nature of poisoning shows a regional variation depending upon the agent predominantly in use. Widespread use of organophosphates in industrial and agricultural application is responsible for an estimated 25 million poisoning cases worldwide.³

Manipal is a rural township in Udupi district of coastal Karnataka situated in Southern India, and Kasturba Hospital is the apex teaching hospital of Kasturba Medical College, Manipal, affiliated to Manipal University. Gender differences with regard to suicidal poisoning in this region have been previously addressed.⁴ This retrospective hospital based research was done with an aim to describe toxicoepidemiology of fatal poisoning in relation to the manner of poisoning including cases of accidental origin in the region. The results of the study are compared with poisoning mortalities in other parts of India, the Indian sub-continent and Europe.

2. Materials and methods

This retrospective review was carried out in the Department of Forensic Medicine and Toxicology, Kasturba Medical College, Manipal. The study included 198 poisoning deaths autopsied

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between January 2000 and December 2006 at the aforementioned centre. In India, all suspected and known poisoning deaths are autopsied and relevant viscera, blood and urine are preserved for chemical analysis. The toxicological analysis of viscera and body fluids is carried out in Government sponsored Regional Forensic Science Laboratories in all poisoning deaths for detection and identification of poison.

A detailed victimologic profile was prepared based on autopsy records and information furnished by the police in the inquest documents. Identification of poison responsible for the fatal outcome was based on the chemical analysis reports furnished by the Regional Forensic Science Laboratories. Different variables like diurnal and seasonal variations along with the manner of death were studied. The data were registered in a database and analysed using Statistical Package for Social Sciences (SPSS) version 10.0. Chi square (χ^2) test was performed to see the significance of each group. p -value <0.05 was considered significant.

3. Results

A total of 1054 medicolegal autopsies were conducted between January 2000 and December 2006. Deaths due to poisoning constituted 18.8% ($n = 198$) of the total autopsied cases during the study period. Annual distribution of poisoning mortalities is shown in Table 1. Majority of the victims ($n = 141$, 71.2%) were males. The male-female ratio was 2.5:1. The age of the victims ranged from 2 to 82 years, with a peak incidence in the 3rd decade of life, after which a gradual decline was evident. 3rd to 5th decades were the most affected age groups, together accounting for 67.2% ($n = 133$) of the total poisoning fatalities (Fig. 1). The overall age of the victims (Mean \pm S.D) was 38.4 ± 15.99 years, 40.29 ± 16.37 in males and 32.81 ± 13.72 in females.

Statistical analysis of different variables examined along with the level of significance is shown in Table 2. The manner of death was suicidal in 92.9% ($n = 184$) and accidental in 6.1% ($n = 12$) cases. The exact manner of death remained unknown in two cases. No homicidal poisoning deaths were reported during the study period. 87.9% of the victims ($n = 174$) were Hindus, followed by 8.6% Christians ($n = 17$) and 3% Muslims ($n = 6$). The time of consumption of poison was known in 66.7% cases ($n = 132$); 65.9% of these victims ($n = 87$) consumed poison during the daytime (8am to 8pm). 58.5% of the poisoning deaths ($n = 116$) occurred during the first half of the year (January to June). Least mortalities ($n = 48$, 24.24%) were reported during the rainy season (June to September), while majority of the poisoning fatalities ($n = 79$, 39.9%) were noticed during the summers (February to May) followed by the winters (October to January). The monthly distribution of poisoning fatalities is shown in Fig. 2.

Agrochemical agents were the main culprit with organophosphates alone responsible for 68.7% ($n = 136$) of the mortalities followed by zinc phosphide, medicinal agents and carbamates. Paraquat, organochlorines, aluminium phosphide, phosphorus, glycosides, copper sulphate, formic acid, kerosene, alcohol, phenol

Table 1
Annual distribution of poisoning mortalities.

Year	Autopsies conducted	Poisoning fatalities	Percentage
2000	163	39	23.9
2001	199	36	18.1
2002	158	29	18.4
2003	113	20	17.7
2004	129	18	13.9
2005	137	24	17.5
2006	155	32	20.6
Total	1054	198	18.8

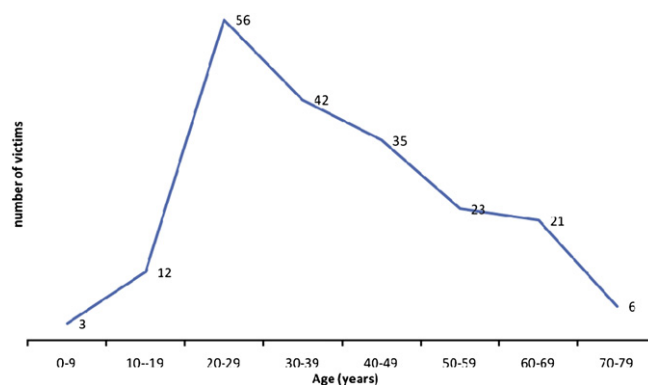


Fig. 1. Age distribution of victims.

and carbon monoxide were the other agents responsible for the fatalities. In seven cases chemical analysis report from the Regional Forensic Science Laboratory was not received as yet (Table 3). In eight cases alcohol was consumed along with the other substance detected, whereas in four cases, acute alcohol intoxication was responsible for the terminal event.

4. Discussion

In our rural set up deaths due to poisoning constituted 18.8% of the total autopsied cases that was quite high as compared to other parts of India and abroad.⁵⁻⁷ Most of the fatal poisonings in our study were a result of self-poisoning. This is similar to other studies in India, and is attributed to a general belief that poisoning kills with a minimal suffering.^{5,8-11} However, in Denmark and Pakistan, the incidence of suicidal poisoning was relatively lower.^{12,13} Organophosphates were implicated in majority (68.7%) of the mortalities followed by rodenticides and medicinal agents. Our findings were comparable to the studies at Yawatmal and Jamnagar in Western India,^{1,14} Shimla in Northern India⁵ and Orrisa in Eastern India,¹² but

Table 2
Victimologic profile in poisoning fatalities.

	Number of cases (n)	Percentage (%)
Gender distribution		
Male	141	71.2
Female	57	28.8
Total	198	100.0
$\chi^2 = 35.63$, $df = 1$, $p < 0.001$		
Religion wise distribution		
Hindu	175	88.4
Muslim	06	3.0
Christian	17	8.6
Total	198	100.0
$\chi^2 = 270.93$, $df = 2$, $p < 0.001$		
Manner of fatal poisoning		
Suicidal	184	92.9
Accidental	12	6.1
Unknown	02	1.0
Total	198	100.0
$\chi^2 = 317.20$, $df = 2$, $p < 0.001$		
Diurnal variation		
Day	87	65.9
Night	45	34.1
Total	132	100.0
$\chi^2 = 13.36$, $df = 1$, $p < 0.001$		
Seasonal variation		
Summer	79	39.9
Winter	71	35.9
Rainy	48	24.2
Total	198	100.0
$\chi^2 = 7.85$, $df = 2$, $p < 0.001$		

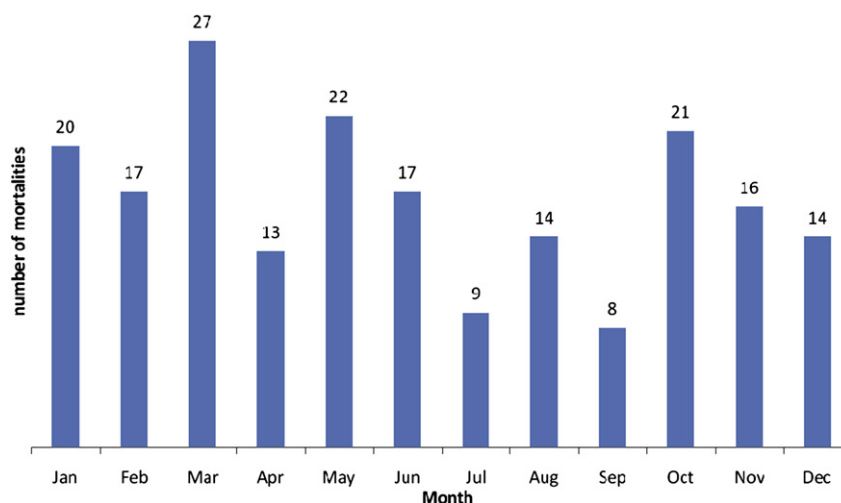


Fig. 2. Monthly distribution of cases.

not with other studies in Northern India, where the pesticide, aluminium phosphide, has taken over as the major cause.^{2,8,15,16} This is attributable to the fact that organophosphates continue to be the most commonly used agrochemicals in Southern India.¹⁷ No fatal homicidal poisoning was reported during the study period suggestive of the fact that poisoning is no longer a preferred means of homicide in this part of the country, similar to a study done in Western India.¹⁴ Modern techniques of sample analysis and established means of detecting poison are thought to be responsible for the fall in homicidal poisoning mortalities throughout India.¹¹

Males were more frequently affected which can be attributed to the fact that they are subjected more rigorously to the temptations, challenges, stresses and strains than females.^{18–20} Easy access to agrochemicals may be a contributing factor.²¹ The male–female ratio (2.5:1) was similar to other studies.^{8,9,14,22–24} In Orrisa, Eastern India and Dhaka, Bangladesh the incidence of mortalities amongst males and females was approximately equal,^{6,25} whereas in Peshawar, Pakistan the male–female ratio was remarkably high.¹² A female predominance has been reported in studies done in Imphal and Maharashtra in India, and Norway.^{7,26,27} The reasons for female predominance in these regions remain unclear. Most of the victims were in the 20–49 years age group, similar to studies done in other parts of India and abroad.^{6,9,10,14,15,23,24} The peak incidence during the 3rd and 4th decades is expected, as this age group comprises the majority of the population and can be attributed to the tremendous stress a person is put to during this period of life. During the study period only three poisoning fatalities were recorded in children. Similar findings have been reported by surveys done in the Indian sub-continent and Europe.^{5,12,14,28} The manner of death was accidental in all three reported cases where the victims were aged between two and four years. In children accidental poisoning forms the bulk of the poisoning cases and low mortality in children is attributed to greater public awareness,

appropriate safety and therapeutic measures taken, resulting in decline of accidental poisoning fatalities in children.²⁹ Organophosphate compounds were responsible for all fatal accidental poisonings in children during the study period. India is predominantly an agriculture based country, and frequent use of agrochemicals, predominantly organophosphate compounds in this part of rural India is responsible for these accidental poisoning deaths. Poison stored in easily accessible places expose children to greater risk of poisoning.³⁰ Most of the poisoning mortalities were reported in Hindus, followed by Christians and Muslims. In India, 83.8% of the population is Hindus, 12.2% is Muslims, 1.9% is Christians and the remaining belongs to other religions.³¹ However, in this region besides Hinduism, a significant part of the population consists of followers of Christianity followed by Islam. Higher incidence of poisoning fatalities among Hindus in addition can be attributed to the fact that maximum inhabitants of the region who are engaged in agriculture related occupations follow Hinduism and as such the farming community is reported to be more prone to suicides.³² The findings are similar to studies done elsewhere in India.¹⁴ Islam strictly forbids suicide. This may be the reason for a lower incidence amongst Muslims,³³ similar to a study done in Peshawar, Pakistan which is a Muslim country.¹²

Most of the victims consumed poison during daytime, similar to the studies done in Orrisa and Allahabad.^{24,34} Suicide is considered as an impulsive act and stress during working hours makes a person more vulnerable. A little premeditation has been reported in suicides by poisoning.²¹ Majority of the poisoning deaths were reported in the first half of the year. Seasonal variation was evident with least fatalities occurring during the rainy season and majority during summers followed by winters, similar to a study in Eastern India where majority of the fatalities were reported during summers.²⁴ In Northern and Western India, the incidence however was more in the rainy season.^{35,36} Month wise distribution of cases saw a peak incidence of poisoning fatalities in March and May. In Western India however, peak incidence was noted in the months of June, July and August. This difference in pattern of seasonal variations and month wise distribution of fatal poisoning cases remains unclear and can be due to differences in climatic conditions prevalent in this coastal area.⁴ Differences in agricultural practices and availability of agrochemicals during the pesticide spraying season in different regions have been found to have a contributory effect.³⁷ However, we could not establish any such relation in our study.

Table 3
Agents responsible for poisoning mortalities (RFSL).

Agent	Poisoning fatalities (n)	Percentage (%)
Organophosphates	136	69.2
Zinc phosphide	16	7.7
Medicinal preparation	08	4.1
Carbamates	07	3.6
Others	24	11.8
Unknown	07	3.6
Total	198	100

5. Conclusions

The study highlights the pattern of poisoning fatalities in Manipal and reveals that poisoning fatalities amounted for nearly 19% of the total autopsied cases. Majority of the victims were males in the 3rd to 5th decades, which is the most active and productive phase of life. Self-poisoning was the predominant manner and organophosphates were responsible for majority of the fatalities. The manner of poisoning was accidental in less than 10% of cases. Homicidal poisoning was not observed in the region during the study period. By virtue of statistical considerations it can be concluded that a Hindu male in his 3rd decade is most prone to fatal suicidal organophosphate poisoning during daytime in summer months.

6. Limitation of the study

Limitations exist as they arise primarily from the fact that this is a retrospective study. A major limitation of the study is that only qualitative analysis of the postmortem viscera and blood was done. Moreover, the particular substance or compound was not further identified under a group of compounds especially, organophosphate compounds. Our approach to the study reveals that quantitative chemical (toxicological) analysis is required to further strengthen and improve the databases of epidemiology of poisoning in our region.

Conflict of Interest

The authors have no conflict of interest to declare.

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Ethical Approval

Not applicable.

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